

# Radiation Closure Studies for Clear-Sky Conditions During the ARM 2003 Aerosol Intensive Observation Period

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# Setup

- Atmospheric Radiation Measurement central facility between Billings and Lamont, OK
- May 5-30 (2003 Aerosol IOP)
- Clear-sky screening using shortwave direct and diffuse plots, 870 nm diffuse, and TSI images
- Same ssa, g, aod, spectral surface albedo, ET spectrum, ozone, water vapor, surface pressure

# Measurements

- Ground-based single scattering albedo, asymmetry parameter from ARM AOS (nephelometers and psap)
- NIMFR for AOD with CIMEL checks
- Cavity or NIP for direct; diffuse is avg of CM22 corrected for offset and 8-48(B&W)
- TOMS/Dobson ozone; MWR H<sub>2</sub>O column
- Std measurements of temperature, RH, pressure

# Models Used

- SBDART 2.4 (uses DISORT)
- SMARTS 2.9.4 (parameterized diffuse)
- RAPRAD ( $\Delta$ -2 stream approach developed by Toon, McKay, and Ackerman (1989) as implemented in Kato et al. (JGR 1997))
- MODTRAN 4.3.1 (uses DISORT)

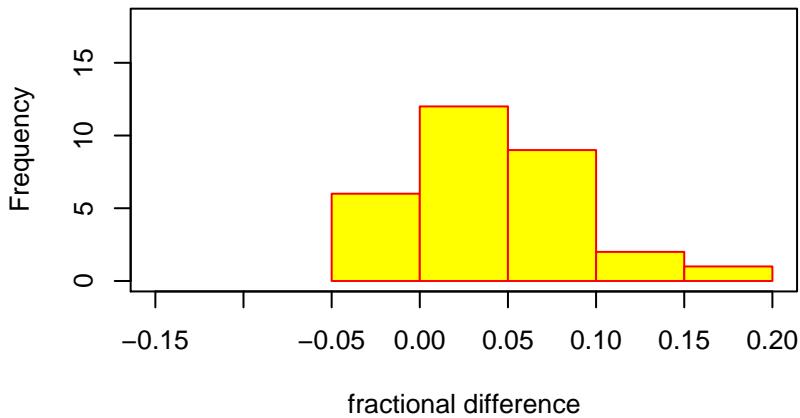
Date	CST	solar elevation	AOT 500	aeronet/500	SSA	g
5-May-03	645	13.257	0.053	0.063	0.888	0.58
	800	28.195	0.055		0.93	0.692
	910	42.147	0.053		0.93	0.556
	1200	68.841	0.074		0.918	0.535
	1600	38.897	0.073		0.949	0.552
	1800	14.967	0.082		0.927	0.591
6-May-03	1730	21.055	0.14		0.929	0.573
	1815	12.169	0.137		0.918	0.549
7-May-03	730	22.525	0.138		0.925	0.628
	930	46.408	0.098		0.853	0.537
9-May-03	930	46.746	0.257	0.265	0.95	0.636
	1130	67.101	0.296	0.304	0.935	0.61
	1230	70.773	0.266	0.266	0.944	0.608
10-May-03	700	17.402	0.489	0.526	0.952	0.662
11-May-03	700	17.192	0.076		0.972	0.505
	920	45.104	0.083		0.971	0.573
	1230	71.294	0.085		0.944	0.582
	1500	51.46	0.071		0.957	0.552
12-May-03	730	23.288	0.081		0.883	0.572
	950	51.079	0.083		0.934	0.562
20-May-03	1400	63.701	0.198	0.203	0.93	0.64
22-May-03	800	30.421	0.195		0.939	0.66
27-May-03	1300	73.124	0.295	0.284	0.943	0.6
	1600	41.672	0.301		0.954	0.611
28-May-03	730	24.89	0.231		0.93	0.607
	1800	17.942	0.199		0.951	0.619
29-May-03	830	36.918	0.144		0.938	0.611
	1230	75.022	0.127		0.946	0.6
30-May-03	1130	70.637	0.168	0.166	0.922	0.577
	1445	56.792	0.158	0.157	0.939	0.612

Direct (meas'd)	sbdart/jim	raprad/seiji	smarts/chris2	Diffuse (meas'd)	sbdart/jim	raprad/seiji	smarts/chris2
604	593	611	601	51	51	50	49
827	809	825	814	70	76	74	74
913	899	914	904	78	83	80	79
968	950	965	959	95	103	100	98
859	850	863	856	90	92	89	87
571	559		567	64	63		60
643	634	662	651	83	83	80	78
474	456		481	58	58		55
669	651	682	668	82	86	83	82
882	872	893	880	96	93	89	88
757	741	768	764	184	195	184	183
798	785	810	808	220	228	217	216
816	807	830	827	205	216	206	204
263	237	276	281	128	132	131	127
681	665	694	680	60	63	61	60
910	899	920	910	87	97	92	91
971	958	976	969	91	107	103	101
936	929	947	938	84	94	90	89
750	733	759	744	67	69	67	67
909	909	930	918	95	95	91	89
854	845	870	878	148	151	146	130
694	676	704	694	114	118	112	109
844	822	847	844	185	198	191	185
732	703	733	729	160	172	164	159
601	582	613	603	106	107	104	102
534	509		533	81	85		80
774	763	784	775	105	108	103	101
903	894		904	117	124		115
865	852	870	863	134	139	133	131
844	837	856	848	121	129	123	121
761.5	747.3	792.4	763	108.6	113.8	114.0	107
		783.2				113.0	
	1.9% lo	1.1% hi	0.2% hi		4.8% hi	0.8% hi	1.6% lo

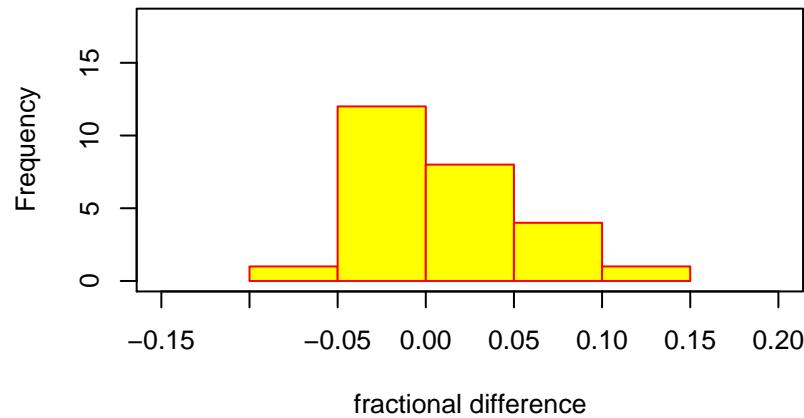
Direct (meas'd)	sbdart/joe direct	sbdart/jim direct	sbdart/allison direct	Diffuse (meas'd)	sbdart/joe diffuse	sbdart/jim diffuse	sbdart/allison diffuse
604	593	593	590	51	50	51	50
827	809	809	805	70	75	76	75
913	899	899	894	78	82	83	82
968	949	950	944	95	102	103	102
859	849	850	845	90	91	92	91
571	559	559	557	64	62	63	62
643	633	634	630	83	82	83	82
474	455	456	453	58	57	58	57
669	651	651	648	82	85	86	85
882	871	872	867	96	92	93	91
757	741	741	736	184	194	195	193
798	785	785	779	220	227	228	227
816	807	807	801	205	215	216	214
263	237	237	235	128	131	132	131
681	665	665	662	60	62	63	62
910	899	899	893	87	96	97	96
971	958	958	951	91	106	107	106
936	928	929	922	84	93	94	93
750	733	733	729	67	69	69	68
909	908	909	903	95	94	95	94
854	845	845	840	148	150	151	150
694	675	676	672	114	117	118	116
844	822	822	816	185	197	198	197
732	702	703	698	160	171	172	170
601	581	582	579	106	106	107	106
534	509	509	506	81	84	85	84
774	763	763	759	105	107	108	106
903	893	894	889	117	122	124	123
865	851	852	847	134	138	139	138
844	836	837	832	121	128	129	128
761.5	746.9	747.3	742.7	108.6	112.8	113.8	112.6

Direct (meas'd)	sbdart/jim2 direct	Diffuse (meas'd)	sbdart/jim2 diffuse
604	620	51	48
827	826	70	70
913	913	78	76
968	960	95	96
859	864	90	86
571	581	64	60
643	652	83	79
474	478	58	56
669	669	82	82
882	884	96	87
757	751	184	190
798	794	220	222
816	816	205	209
263	245	128	131
681	688	60	58
910	912	87	90
971	969	91	99
936	941	84	87
750	752	67	64
909	921	95	88
854	855	148	144
694	690	114	113
844	831	185	192
732	713	160	167
601	596	106	103
534	526	81	82
774	776	105	102
903	904	117	116
865	861	134	132
844	847	121	123
761.5	761.2	108.6	108.4

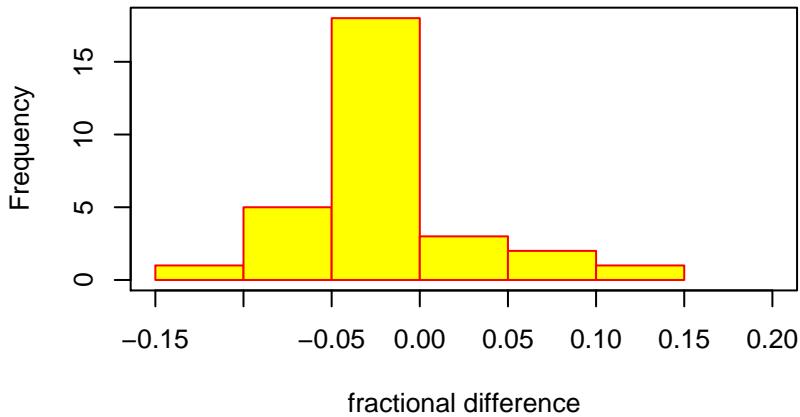
**histogram of (sbdart – measurement) for diffuse**



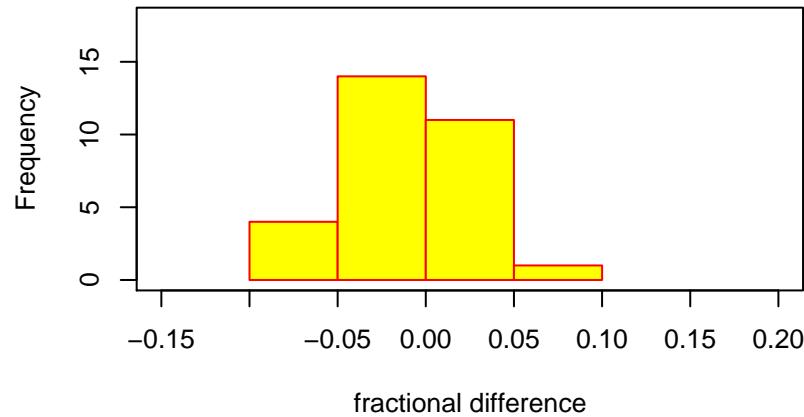
**histogram of (raprad – measurement) for diffuse**



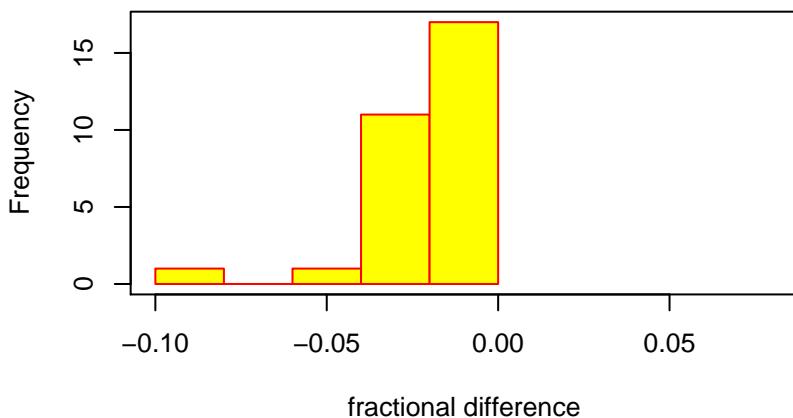
**histogram of (smarts – measurement) for diffuse**



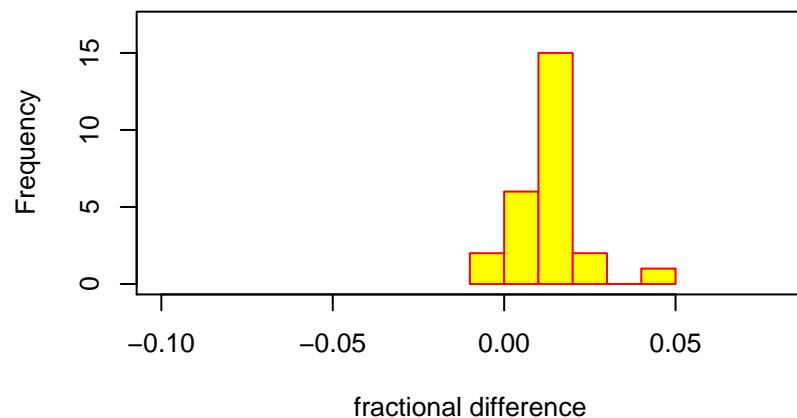
**histogram of (sbdart+ – measurement) for diffuse**



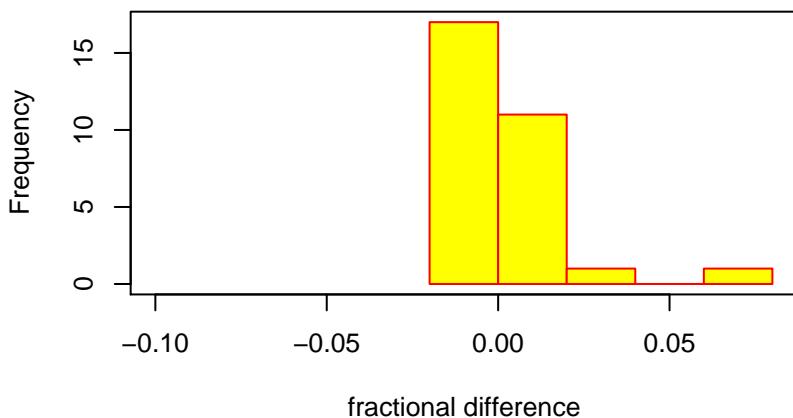
**histogram of (sbdart – measurement) for direct**



**histogram of (raprad – measurement) for direct**



**histogram of (smarts – measurement) for direct**



**histogram of (sbdart+ – measurement) for direct**

